Series 1400 Pulsatile Blood Pumps User's Manual

Model 1405 PBP for Rabbits	*55-1838*
Model 1407 PBP for Mice/Rats	*52-9552*
Model 1421 PBP for Dogs/Monkeys	*55-3321*
Model 1423 PBP for Large Animals; Hemodynamic Studies	*55-3305*

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Serial Numbers

All inquires concerning our product should refer to the serial number of the unit(s).

Warranty

Harvard Apparatus warranties the instrument(s) for a period of one year from date of purchase. At its option, Harvard Apparatus will repair or replace the unit(s) if it is found to be defective as to workmanship or material.

This warranty does not extend to damage resulting from misuse, neglect or abuse, normal wear and tear, or accident.

This warranty extends only to the original customer purchaser.

IN NO EVENT SHALL HARVARD APPARATUS BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES. Some states do not allow exclusion or limitation of incidental or consequential damages so the above limitation or exclusion may not apply to you. **THERE ARE NO IMPLIED WARRANTIES OF MERCHANTABILITY, OR FITNESS FOR A PARTICULAR USE, OR OF ANY OTHER NATURE.** Some states do not allow this limitation on an implied warranty, so the above limitation may not apply to you.

If a defect arises within the one-year warranty period, promptly contact **Harvard Apparatus, Inc. 84 October Hill Road, Holliston, Massachusetts 01746-1371** using our U.S. only toll free number 1-800-272-2775 or dial (508) 893-8999. Goods will not be accepted for return unless an RMA (returned materials authorization) number has been issued by our customer service department. The customer is responsible for shipping charges. Please allow a reasonable period of time for completion of repairs, replacement and return. If the unit is replaced, the replacement unit is covered only for the remainder of the original warranty period dating from the purchase of the original device.

This warranty gives you specific rights, and you may also have other rights which vary from state to state.

Repair Facilities and Parts

Harvard Apparatus stocks replacement and repair parts. When ordering, please describe parts as completely as possible, preferably using our part numbers. If practical, enclose a sample or drawing. We offer a complete reconditioning service.

CAUTION: Not for clinical use on human patients.

Theory of Operation

This family of four pumps, all similar in concept but differing in capacity, are intended to pump blood with minimum damage to blood cells. All pumps feature a mechanically activated piston moving back and forth in a transparent cylinder. The geometry of the piston actuation is such that the piston travels to the very end of the cylinder regardless of the stroke volume selected. This feature insures that blood is completely emptied from the cylinder at each stroke.

The valve cages and liquid pathway have been carefully designed to provide a streamlined flow with no sharp edge to minimize hemolysis.

All parts of the liquid pathway can be disassembled for cleaning and sterilization. In all pumps the volume per stroke and the strokes per minute can be adjusted while the pumps are running.

The two smaller pumps #1405 and #1407 have mechanically fixed systole/diastole ratios of .33, that is, diastole lasts twice as long as systole. The larger pumps #1421 and #1423 have electronically variable ratios in which systole can be adjusted to be 25 to 50% of the total pumping cycle.

Specifications

The specifications of all pumps are compared in the following chart.

Harvard Pulsatile Blood Pump Comparison Chart				
Catalog No.	**52-9552**	**55-1838**	**55-3321**	**55-3305**
Model No.	1407	1405	1421	1423
Stroke Volume	0.05 to 1.0 ml	0.5 to 10.0 ml	4 to 30 ml	15 to 100 ml
Stroke Rate (per min)	20 to 200	20 to 200	20 to 200	10 to 100
Minimum Volume (vol x rate)	1 to 200 ml	5 ml to 2.0 liters	80 ml to 6 liters	150 ml to 10 liters
Phasing	Fixed Phase 35% systole 65% diastole	Fixed Phase 35% systole 65% diastole	Adjustable Phase 35 to 50% of total cycle	Adjustable Phase 35 to 50% of total cycle
Tube Size (ID)	5/16 in	5/16 in	1/2 in	5/8 in
Piston Diameter	1/4 in	3/4 in	1-1/8 in	2 in
Ball Valve Diameter	5/16 in	5/16 in	1/2 in	5/8 in
Dimensions	312 x 156 x 250 mm (12.5 x 6.25 x 10 in)	312 x 156 x 250 mm (12.5 x 6.25 x 10 in)	500 x 212 x 337 mm (20 x 8.5 x 13.5 in)	500 x 212 x 337 mm (20 x 8.5 x 13.5 in)
Weight	7.3 kg (16 lb)	7.3 kg (16 lb)	13.6 kg (30 lb)	14.5 kg (32 lb)
Power Used	50 W	50 W	85 W	85 W
Voltage	115/230 V 50-60 Hz	115/230 V 50-60 Hz	115 V 50-60 Hz	115 V 50-60 Hz
Application	Mice/Rats	Rabbits	Dogs/Monkeys	Large Animals; Hemodynamic Studies

Installing the Pump

Both of the smaller pumps #1405 and #1407 are equipped with a voltage selector switch for either 120 or 220 volt usage. BE SURE THIS SWITCH IS SET FOR YOUR VOLTAGE.

For 220 volt operation the American line cord plug must be cut-off and an appropriate plug installed. The line cord is color coded in International standard colors.

Brown – High
Blue – Neutral
Green – Ground

Observe these polarities. PUMPS ARE NOT EXPLOSION PROOF.

Operation for All Pumps

The inlet nozzle is always at the bottom of the pump head. Pumps are self-priming and will lift liquids from reservoirs up to 50 centimeters below the inlet.

Since the valves of the pump are passive ball valves liquid will flow thru the pump without the pump running if –

1. The inlet reservoir is above the outlet
2. The inlet pressure is higher than the outlet pressure
3. The outlet tubing is below the inlet, this can cause siphoning or gravity induced flow

The volume pumped per minute is called the "minute volume". It is the product of the stroke volume times the stroke rate. This is only valid if there is a normal amount of back pressure or resistance to flow. Since the pumped liquid has inertia, liquid will continue to flow even in the filling cycle. This can be prevented by having adequate resistance in the output circuit.

Operating Controls

Stroke Volume Adjustment
On smaller pumps the volume is set by turning the stroke volume control located at the top of the pump. Volume is read from the decal fastened to the pump cylinder. Volume is determined by watching the excursion of one "O" ring. Volume should be adjusted while the pump is running. A thumb screw is built-in to the volume control to provide positive locking once the volume is set.

On larger pumps the volume control is at the top while the actual volume is read from a calibrated plate on the side of the pump. A locking knob next to the volume pointer provides positive locking.

Rate Adjustment (strokes per min)
On small pumps the rate control is at the top of the pump, on large pumps the rate control is at the end of the pump opposite the pump head.

Output Phase Ratio
The larger pumps are equipped with a control to adjust the ratio of systole to diastole. This control is located adjacent to the rate control. The control is continuously variable from 25/75 to 50/50. In the 25/75 position, systole takes place in 25% of the cardiac cycle while diastole takes place in 75%. This is observed by watching the piston/cylinder eject liquid quickly and fill slowly in the 25/75 position. In the 50/50 position the piston speed is the same in filling and emptying.

The phase ratio has an affect on the rate control (see figure 1 on next page). The observed stroke rate varies considerably from the set rate as the phase ratio reaches its outer limits.

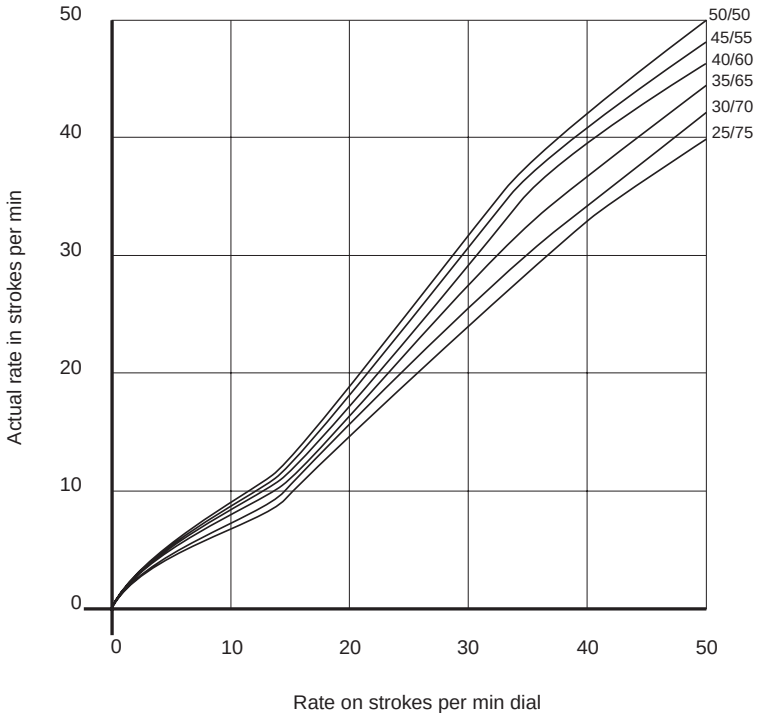


Figure 1. Dual Phase Rate Compensation Chart.
Phase ratio (% systole); typical plot of actual stroke rate at various ratios and strokes.

Care and Maintenance

Disconnect from the power source before performing any motor maintenance.

Pumping Head

The Pumping Head is easily removed for cleaning, sterilization and lubrication. Refer to the diagram for part designation on the Standard 10 cc #1405 Pumping Head. Follow the instructions below for removing the Head:

1. Using the Stroke Rate and Stroke Volume Controls allow the Piston to recede to the furthest end of its travel. (Note:The stroke volume control should be set for maximum volume delivery).
2. Remove the thumbscrews attaching the cylinder and the valve head.
3. Gently pull the Cylinder away from the black plate until it clears the short binding posts extending from this plate.
4. Slide the Head and Cylinder assembly off the piston.
5. If Piston removal is desired, hold the Piston in one hand and use a small open-end wrench to loosen the hex Coupling. The Piston can then be unscrewed from the Coupling.

Cleaning and Sterilization

For non-sterile applications, clean parts from all residues with water and a damp cloth. Flush the head and valves before reassembly to make sure that all cloth fibers and other materials are cleared. For sterile applications, either gas or cold sterilization agents can be used.

Lubrication

Apply a light coating of the silicone grease provided to the Piston and the inside of the Cylinder.

Valves

The Valves are easily disassembled for cleaning. The 'O' rings can be removed for cleaning and replacement. Refer to the drawing when the components are to be reassembled.

Pump Mechanism

The entire pump mechanism is available for inspection and lubrication by removing the bottom cover and the control panel assembly. The bottom cover is removed by loosening the screws within the four rubber feet. The control panel assembly is removed by (1) loosening the set screw on the Stroke Volume Control and removing the knob, (2) removing the eight Phillips-type screws connecting the panel assembly to the housing, and (3) lifting the panel assembly clear of the stroke control shaft.

IMPORTANT: Make sure that the wires remain connected to their appropriate terminals. All bearings and points of frictional contact should be lubricated every 30 days with a light machine oil (Harvard Part No. 0606-060).

Care and Maintenance

Disconnect from the power source before performing any motor maintenance.

Pumping Head

The Pump Head is easily removed for cleaning, sterilization, and lubrication. Refer to diagrams for part designation on the #1421 and #1423 Pumping Heads, respectively. Follow the instructions below for removing the head:

1. Using the spanner wrench provided, insert the wrench-pin into one of the holes in the Nut-Coupling, apply pressure, and loosen. The coupling can now be easily removed from the cylinder.
2. Using the same wrench, insert the wrench-pin into one of the holes on the cylinder, apply pressure, and loosen. Proceed to unscrew the cylinder manually.
3. To remove the Piston, insert the wrench-pin into one of the holes on the Piston, apply pressure, and loosen. Remove the Piston manually.

Cleaning and Sterilization

For non-sterile applications, clean parts from all residues with water and a damp cloth. Make certain that all cloth fibers are cleared from the system before it is reassembled. For sterile applications, either gas or cold sterilization agents can be used.

Lubrication

Apply a light coating of the silicone grease provided to the Piston and the inside of the Cylinder.

Valves

The Valves are easily disassembled for cleaning. The 'O' rings can be removed for cleaning and replacement. Refer to the drawing when the components are to be reassembled.

Pump Mechanism

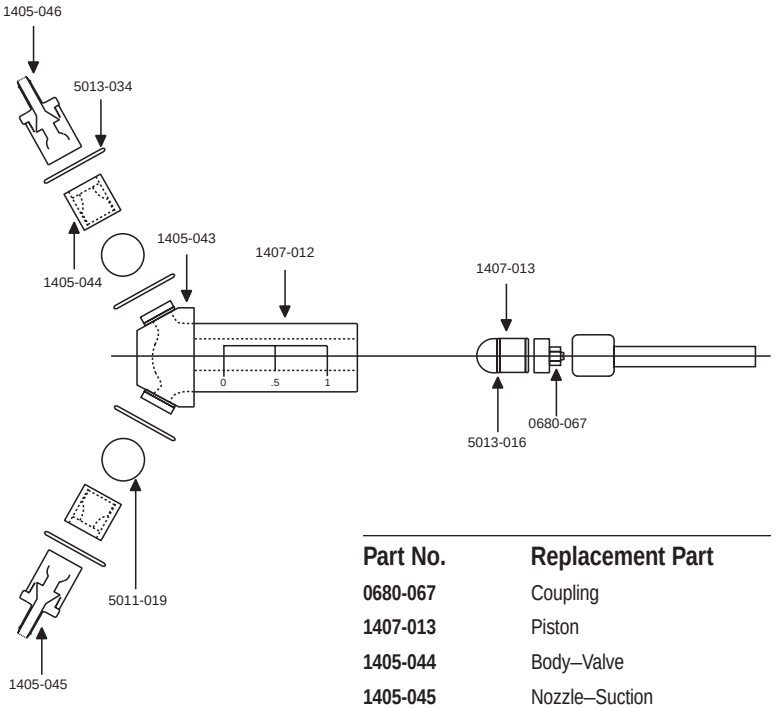
The entire Pump Mechanism is available for inspection and lubrication by removing the blank side panel. All bearings and points of frictional contact should be lubricated every 30 days with a light machine oil (Harvard Part No. 0606-060).

Control

The solid state dual phase Motor Control needs no special attention. If a problem seems to exist in the motor control, the unit should only be examined by a qualified technician. A safety fuse (1 amp. slo-blo type) is provided for overload protection. DO NOT REPLACE with a higher rated fuse.

Drawing and Parts List (1 cc)

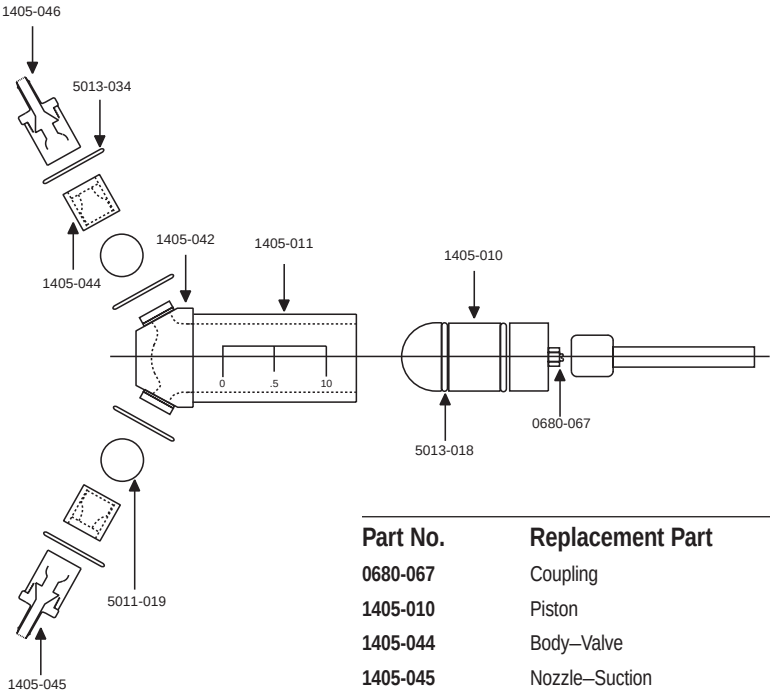
1 cc Standard Pumping Head / 52-9552 / 1407



Part No.	Replacement Part
0680-067	Coupling
1407-013	Piston
1405-044	Body–Valve
1405-045	Nozzle–Suction
1407-012	Cylinder
1405-046	Nozzle–Discharge
5011-019	Ball–SS Bearing, Hard
5013-016	O Ring, Parker #0125-070
5013-019	O Ring, Parker #2-13
1405-043	Head

Drawing and Parts List (10 cc)

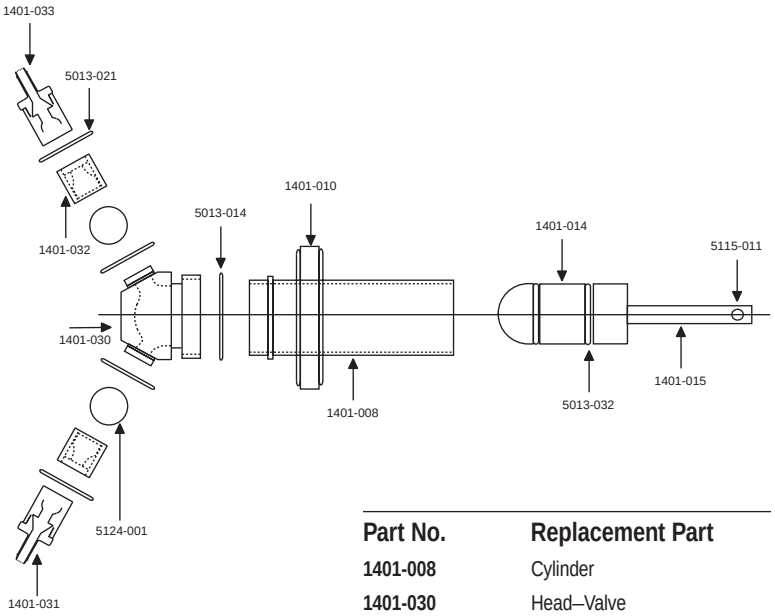
10 cc Standard Pumping Head / 55-1838 / 1405



Part No.	Replacement Part
0680-067	Coupling
1405-010	Piston
1405-044	Body–Valve
1405-045	Nozzle–Suction
1405-046	Nozzle–Discharge
1405-042	Assy–Valve HD & Cylinder
5011-019	Ball–SS Bearing, Hard
5013-018	O Ring, Parker #2-16
5013-019	O Ring, Parker #2-13

Drawing and Parts List (30 cc)

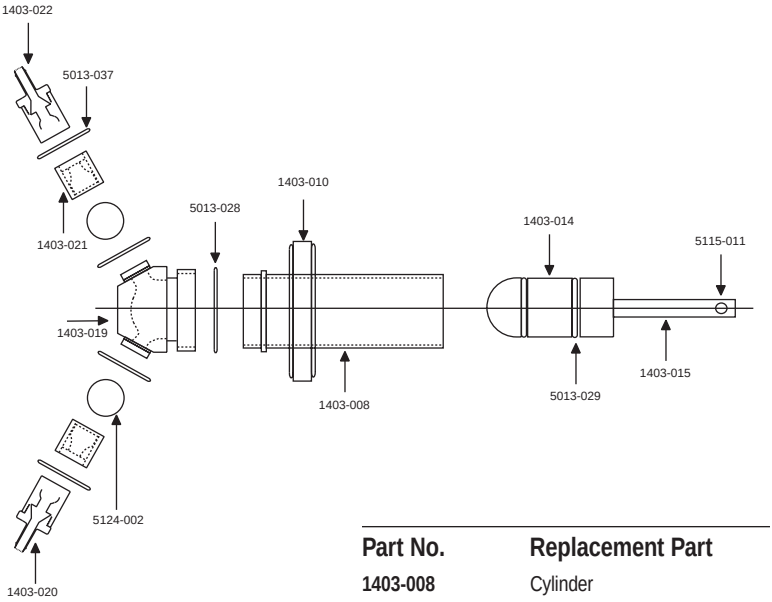
30 cc Standard Pumping Head / 55-3321 / 1421



Part No.	Replacement Part
1401-008	Cylinder
1401-030	Head–Valve
1401-010	Nut–Coupling
1401-031	Nozzle–Suction
1401-032	Body–Valve
1401-033	Nozzle–Discharge
1401-014	Piston
1401-015	Shaft–Connecting
5013-014	O Ring, Parker #2-126
5013-021	O Ring, Parker #2-18
5013-032	O Ring, Parker #2-119
5115-011	Set Screw #8, 32 x 3/16
5124-001	Sphere, 1/2 D

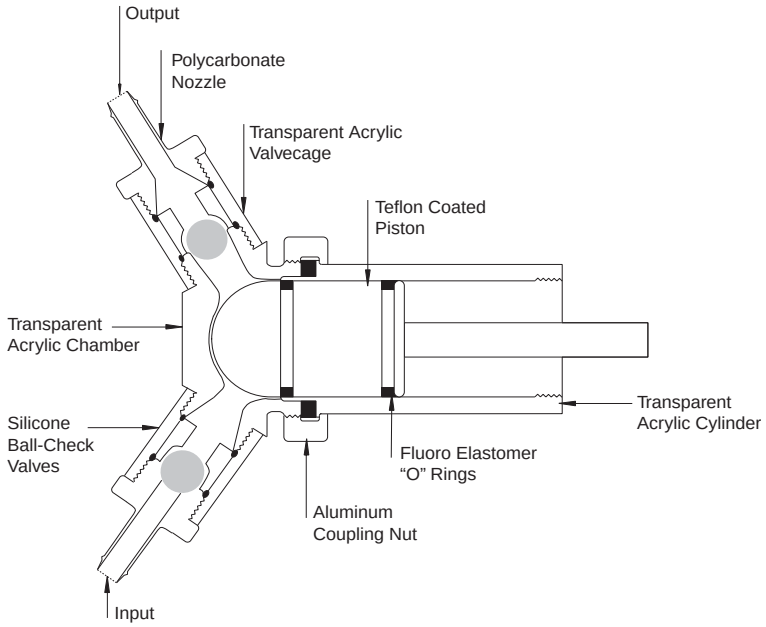
Drawing and Parts List (100 cc)

100 cc Standard Pumping Head / 55-3305 / 1423

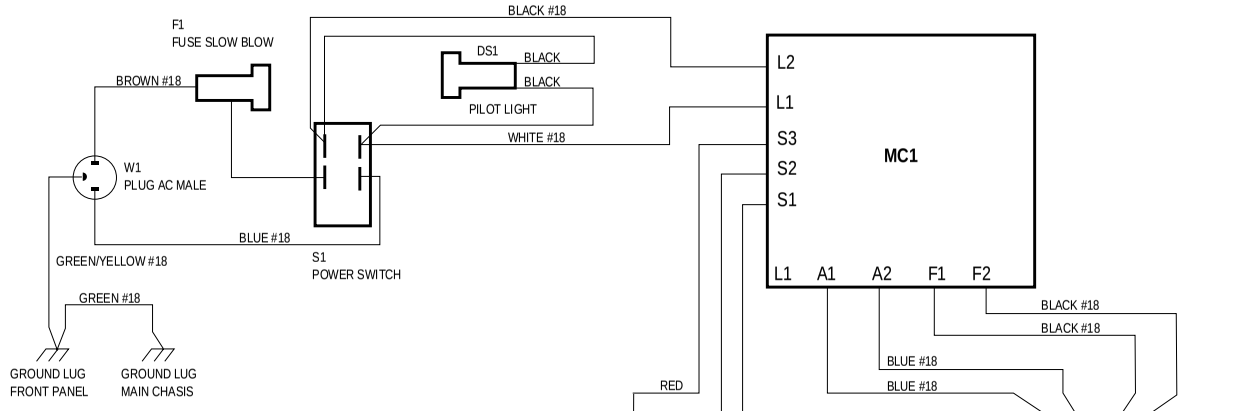


Part No.	Replacement Part
1403-008	Cylinder
1403-019	Head–Valve
1403-010	Nut–Coupling
1403-020	Nozzle–Suction
1403-021	Body–Valve
1403-022	Nozzle–Discharge
1403-014	Piston
1401-015	Shaft–Connecting
5013-028	O Ring, Parker #2-140
5013-029	O Ring, Parker #2-133
5013-037	O Ring, Parker #2-24
5115-011	Set Screw #8, 32 x 3/16
5124-002	Sphere, 3/4 D

Typical Pump Head



Single Phase Motor Speed Control (Models 1405 & 1407)



Catalog No.	Model No.	Power
55-1838	1405	115/240 VAC, 50–60 Hz (1 AMP)
55-3321	1421	115 VAC, 60 Hz (1 AMP)
55-3339	1421A	240 VAC, 50 Hz (1/2 AMP)
55-3305	1423	115 VAC, 60 Hz (1 AMP)
55-3313	1423A	240 VAC, 50 Hz (1/2 AMP)
52-9552	1407	115/240 VAC, 50–60 Hz (1 AMP)

Hemolysis Test Data (Models 1421 & 1423)

In these studies a reservoir of 500 to 800 cc of fresh dog blood was used, connected to the pump by 3/8" PVC tubing. Samples at room temperature were taken at 15 and 30 minute intervals for 4 to 5 hours. Samples were spun down and hemolysis measured immediately using the method of FLINK & WATSON. Since the rate of hemolysis depends on the amount of blood in the system and the flow rate, the results are reported as mg % per pass. The flow rate divided by the volume of blood in the system determines the number of passes through the pump per minute.

Hemolysis ranged from 0.114 mg % to 0.27 mg % per hour pass through the various pumps with an error of ± 10%.

To put these results in perspective most physiological perfusions are run with flow rates and total blood primes, so that the number of passes through the pump will range from about 1/4 to 3/4 per minute. Assuming one pass in two minutes and no physiological removal of the products of hemolysis, then hemolysis rates would range from 3.4 mg % to 8.7 mg % per hour of pump use.

Havard Apparatus pumps are distributed
in the U.S. on a non-exclusive basis by:

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